Magnetic anomaly map for Bharati promontory, Larsemann Hills, East Antarctica

Antarctica is a key element in the earth geodynamic and tectonic system. The East Antarctica region was once conjugate to the southern part of India[1], i.e. the southeastern edge of India and the edge of East Antarctica were juxtaposed together and these two margins possess similar geological history. The transects of geophysical data along these margins can address multifold objectives such as the Mesoproterozoic accretion processes, strengthening break-up theory, and understanding the intricacies pertaining to geodynamics. Based on gravity-magnetic modelling constrained by seismic studies and volcanic rocks found in boreholes, Mishra *et al.*[2] inferred that both these margins are characterized by Permian–Triassic–Cretaceous sediments of the same density and thickness. Details of geologic comparison of southeastern Peninsular India and Sri Lanka with a part of East Antarctica are given by Fedorov *et al.*[3]. Using new seafloor isochrones between the Gunnerus Ridge and Bruce Rice, Gaina *et al.*[4] presented plate reconstruction models for early break-up between India and Antarctica. Reconstructions for the Eastern Gondwanaland[1] indicate that the present-day continental margin of East Antarctica agrees well with the eastern continental margin of India (ECMI) along 2000 m bathymetry between 35°E and 95°E. Golynsky *et al.*[5] used airborne magnetic data to identify a prominent positive magnetic anomaly belt named as the Antarctic Continental Margin Magnetic Anomaly with 120 km width, and a 150–600 nT anomaly which can be taken as a counterpart of the positive magnetic anomaly belt observed along the Indian east coast. Both of these anomaly belts run along the 2000 m bathymetry contour line strengthening the concept of the conjugate nature of the two margins. Further, the conjugate nature of these margins are substantiated from the admittance studies[6]. To obtain detailed shallow subsurface features and composition, a magnetic study has been undertaken in the vicinity of the proposed Indian station named Bharati.

Bharati promontory is an ice-free hilly region with maximum elevation of ~110 m, confined to 76°10′–76°14.5′E and 69°24′–69°25.5′S, covering an area of about 50 sq. km. This area is located approximately halfway between the Vestfold hills and the Amery Ice Shelf (between Stornes and Broknes peninsula; Figure 1) in East Antarctica. Total mag-

Figure 1. Map showing 410 locations (red dots in bottom figure) of total magnetic field measurements in Bharati promontory, Larsemann Hill region, superposed on an areal imagery. The Larsemann Hill area and Bharati promontory are shown as insets in the top and middle figures (Bolingen Islands and Larsemann Hills, published by Australian Government Antarctic Division) respectively.

Table 1. Magnetic field elements at Bharati promontory, computed from IGRF 2001. Source: National Geophysical Data Centre

At Bharati promontory	Declination + East – West	Inclination + Down – Up	Horizontal intensity	North component + North – South	East component + East – West	Vertical component + Down – Up	Total field
11 March 2007	–78°33′	–71°27′	17,144.5 nT	3405.7 nT	–16,802.8 nT	–51,102.2 nT	53,901.4 nT

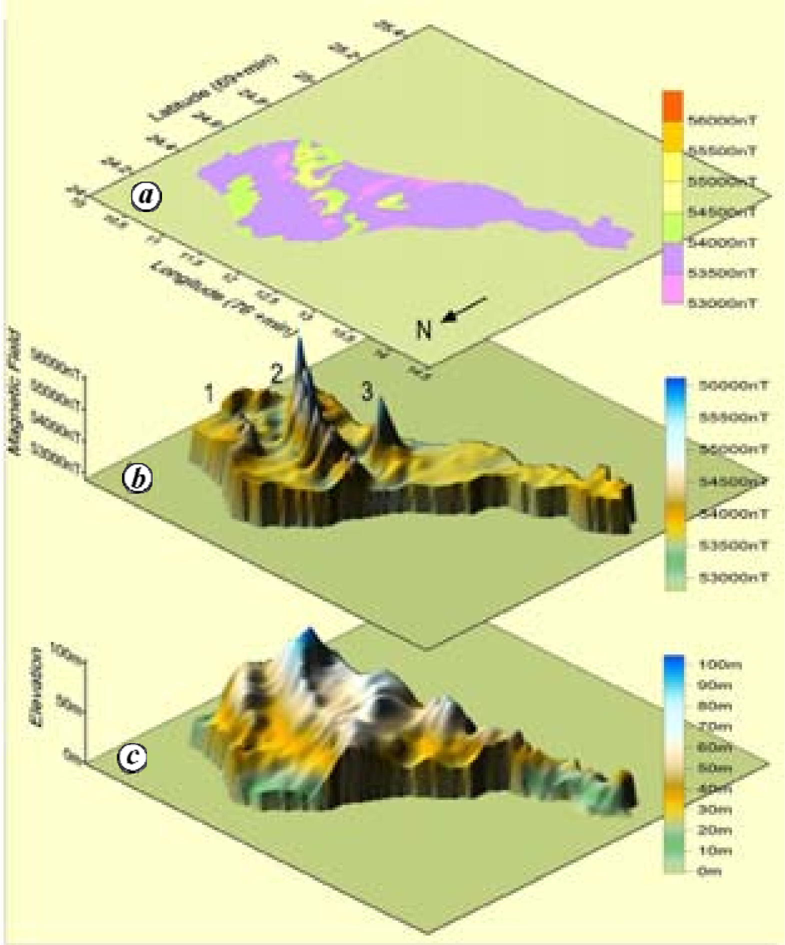

Figure 2. Total magnetic field contour (***a***) and coloured surface relief maps (***b***) for Bharati promontory, Larsemann Hill, East Antarctica, corresponding to the measurements at 410 locations as shown in Figure 1. ***c***, Elevation relief map in WGS84.

netic field (*F*) was measured at 410 locations, during March 2007 Austral summer XXVI Indian Antarctica expedition. The measurement locations are given in Figure 1 superposed on areal imagery. Digital Fluxgate Magnetometer has been continuously operated to facilitate the diurnal variation correction in the total magnetic field.

The magnetic data were utilized to prepare a contour map (Figure 2 *a*) and perspective view of the same (Figure 2 *b*). The elevation map shown in Figure 2 *c* has been prepared with elevations measured at 410 sites along with longitude and latitude, using Garmin single-frequency GPS receiver, in autonomous mode and all the coordinates are in WGS84.

The minimum, maximum and median values of total magnetic field are around 52,000, 53,700 and 56,600 nT respectively. The range is around 4600 nT, which is significantly high. Diurnal corrections have been applied. To get the total intensity anomaly, we have applied International Geomagnetic Reference Field 2001 (IGRF) to the diurnally corrected total magnetic field data. The computed magnetic components are given in Table 1.

As seen from the magnetic field contour map (Figure 2 *a*), magnetic total intensity anomaly map (Figure 3) and the corresponding coloured surface relief map (Figure 2 *b*), it is observed that the high magnetic field anomaly regions are concentrated over some pockets which are located on high ridges seen in the elevation relief map. This can be visualized from Figure 2 *b* and *c*, where a perspective view of magnetic anomalies and elevation is simultaneously given, to see the spatial correlation. In the southern part of the promontory, the magnetic field values generally correspond to background values and no significant anomalies were observed.

The causative source of the anomaly seems to be at a shallow depth, as it is observed that horizontal gradient of about 1000 nT per 50 m at some locations. The most likely candidate for the magnetic anomaly can be the magnetite-bearing gneisses/amphibolitic gneisses, which are present as NE–SW trending bands in the region (Pandit and Dharwadkar, pers. commun.). This can be seen in Figure 2 *a* and *c* and also in Figures 3 and 4 (total intensity anomaly map vis-à-vis geology). This gneisses mainly occupying the higher grounds as seen in Figure 2 *b* (ridges 1–3) is marked by the presence of small magnetite crystals evenly distributed throughout. As seen from Figure 4 (ref. 7), and detailed mapping of this region[8–11], these NE–SW ridges are characterized by garnet–magnetite–biotite gneisses. There are evidences of oxidation of iron-rich material as seen in the form of limonitic surface exposures. Whereas in the Schirmachar area around Maitri (second Indian Antarctic station), no magnetite-bearing rocks have been reported (Pandit and Dharwadkar, pers. commun.).

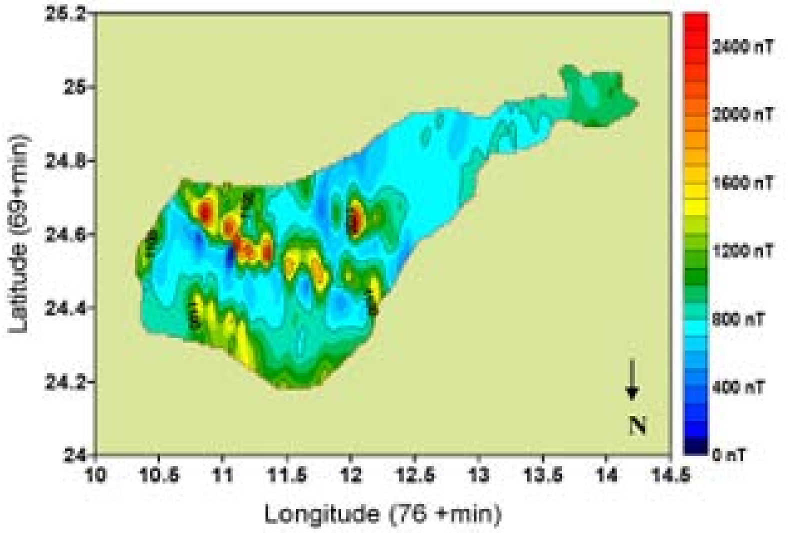

Figure 3. Total intensity anomaly map of Bharati promontory with 100 nT contour interval.

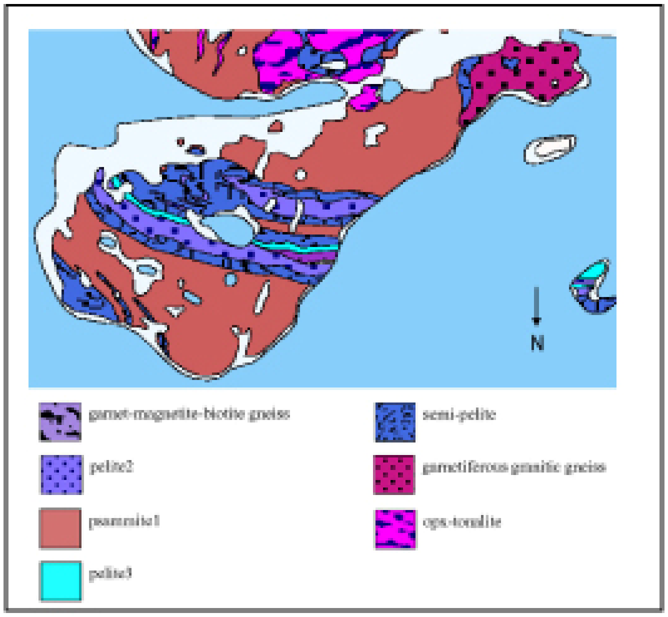

Figure 4. Geology map of the Bharati promontory (extracted from the Geology of the Larsemann Hills – Lithology[7]).

The magnetic field anomalies (1–3; Figure 2), either represent a single litho-unit in folded terrain (appearing at different places on the erosional surface) or three independent magnetite-rich rock units. The observed anomalies vary in dimension and magnitude due to complex geological processes, such as multiple episodes of deformation and shearing. As seen from Table 1, the total magnetic field mainly consists of vertical component (~51,000 nT) and bodies causing the magnetic anomaly have vertical polarization and can be modelled easily. However, the direction of magnetization is measured from oriented samples in this region. This can be an important constraint for numerical modelling. To understand the intricacies and quantitative modelling, detailed geological (petrologic, structural and geo-chemical) studies, supplemented by other geophysical techniques such as gravity, magnetotelluric (MT), low frequency magnetotelluric (LMT), etc. need to be carried out.

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